



The International Astronomical Union
Minor Planet Center

Minor Planet Center 2024 Update

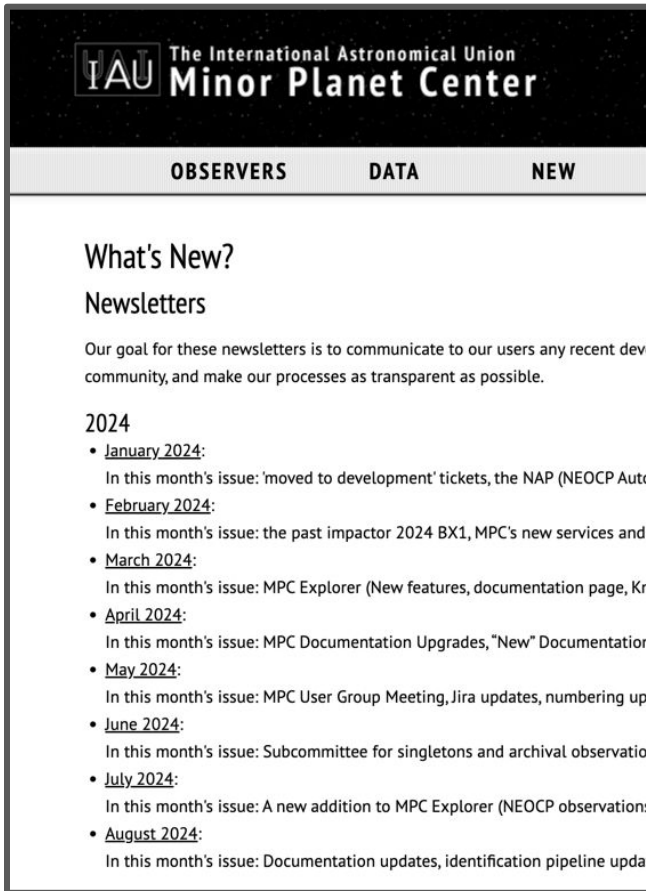
CENTER FOR
ASTROPHYSICS
HARVARD & SMITHSONIAN

Matthew Payne
Center for Astrophysics | Harvard & Smithsonian



Community Interactions





The screenshot shows the top navigation bar with 'OBSERVERS', 'DATA', and 'NEW' tabs. Below is the 'What's New?' section for newsletters, including a goal statement and a list of newsletters for 2024.

IAU The International Astronomical Union
Minor Planet Center

OBSERVERS DATA NEW

What's New?

Newsletters

Our goal for these newsletters is to communicate to our users any recent developments in the community, and make our processes as transparent as possible.

2024

- January 2024:
In this month's issue: 'moved to development' tickets, the NAP (NEOCP Automated) system, and the new MPC Explorer interface.
- February 2024:
In this month's issue: the past impactor 2024 BX1, MPC's new services and the new MPC Explorer interface.
- March 2024:
In this month's issue: MPC Explorer (New features, documentation page, Known Issues, and the new MPC Explorer interface).
- April 2024:
In this month's issue: MPC Documentation Upgrades, "New" Documentation, and the new MPC Explorer interface.
- May 2024:
In this month's issue: MPC User Group Meeting, Jira updates, numbering up, and the new MPC Explorer interface.
- June 2024:
In this month's issue: Subcommittee for singletons and archival observations, and the new MPC Explorer interface.
- July 2024:
In this month's issue: A new addition to MPC Explorer (NEOCP observations), and the new MPC Explorer interface.
- August 2024:
In this month's issue: Documentation updates, identification pipeline updates, and the new MPC Explorer interface.

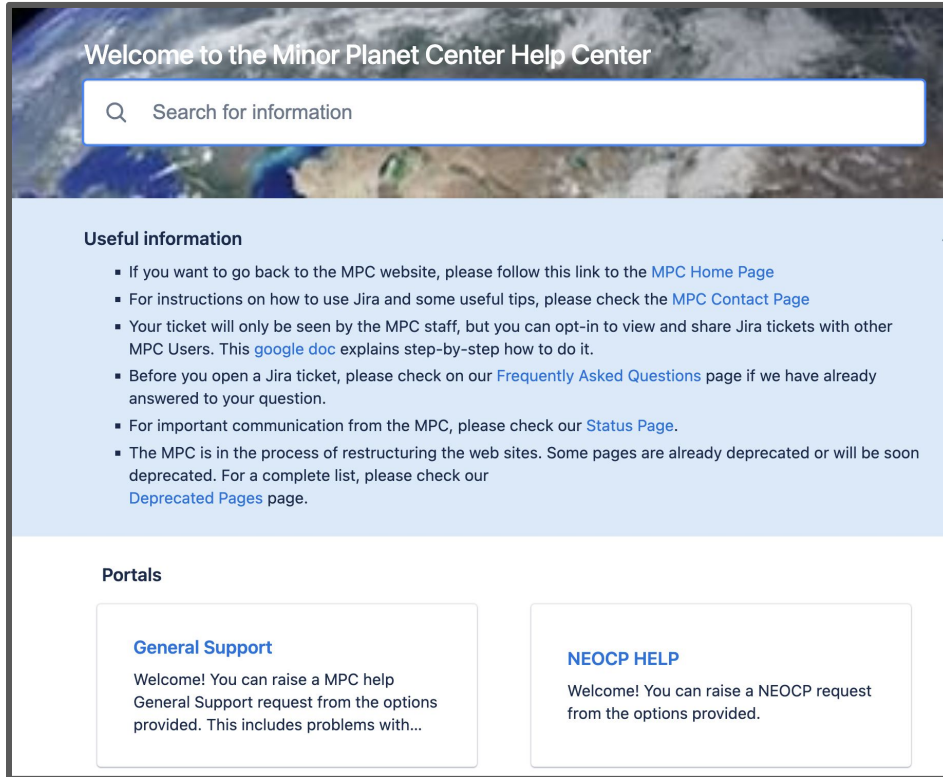
Monthly Newsletter

- Announce new developments
- Provide advice
- Solicit community feedback

Download

- URL:
<https://minorplanetcenter.net/mpcops/new/newsletters/>
- QR Code





Jira Helpdesk

- Dedicated help-desk functionality.
 - Queries
 - Bug reports
 - Requests

Access

<https://minorplanetcenter.net/contact>

<https://mpc-service.atlassian.net/servicedesk/customer/portals>



Announced in [June 2024 Newsletter](#)

In reaction to concerns regarding occasional erroneous measurement of archival data.

- Single measurements especially problematic when no other observations available in an opposition:
- Can significantly change calculate orbit and impact probability.

The MPC and the MUG have formed a committee of impartial external experts to help review individual cases.

- 6 members: PanSTARRS, ATLAS, Catalina, and NEOWISE, one member with follow-up experience, and one non-NASA-funded astrometry expert
- Committee members provide advice:
 - To submitters regarding preferred methodology
 - To MPC regarding accuracy of submitted data

Started to implement this new mechanism on a few test cases.

- Committee members interact with the submitter via Jira ticket.
- Postage-stamp images can be requested and analyzed

The MPC has put a lot of effort into increasing their presence during large conferences and medium or small meetings or workshops.

In the last two years (2023 and 2024), MPC's staff members have attended or are going to attend the following large conferences:

- PDC, April 2023, Vienna
- ACM, June 2023, Flagstaff
- DPS, October 2023, San Antonio
- TNO meeting, June 2024, Taipei
- IAU, August 2024, Cape Town
- DPS, October 2024, Boise

We have also attended smaller size meetings, equally important for the NEO/Asteroid community, such as:

- SBN User Group meetings
- SBAG
- IAWN
- Radar
- ADASS
- NEOO

And workshops in preparation for V. Rubin and NEO Surveyor:

- LSST Science Collaboration meetings
- NEO Surveyor Science Workshop

In addition to that, we are also very active inside the CfA and for outreach events in Cambridge and outside the US.

New Services and Data Products



MPC Explorer

[Designation](#) [NEOCP](#) [Documentation](#) [Known issues](#)

Search for designation (e.g. Benu, A1234, 1, 401P, Jupiter X, K23A00B, 2024 AA, 2019JD24, C/2019 Y4, CK18Y010, S/2020 S1, SK03J020).

Selected Object: [12345](#) ⓘ

[Designation](#) [Observations](#)

Id Type	Values
Permanent ID	12345
Name	None
Object Type	Minor Planet
IAU Designation	(12345)
Unpacked Primary Provisional Designation	1993 FT8
Unpacked Secondary Provisional Designations	1995 UW49
Packed Permanent ID	12345
Packed Primary Provisional Designation	J93F08T
Packed Secondary Provisional Designations	J95U49W

Download JSON

Replacement for our db_search functionality

Available Now

- Designations and Identifications
- Observations
- NEOCP

Coming Soon

- Orbits
- Discovery Details

Access Methods

- Web-forms
- API

URL & QR-Code

- <https://data.minorplanetcenter.net/explorer/>



Database Replication

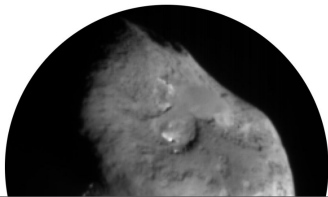


Minor Planet Center Annex

@ SBN

SBN-MPC

The [Minor Planet Center \(MPC\)](#) is the world's ([International Astronomical Union](#) designated) nerve center for asteroid and comet observations, and has become a functional sub-node of the [Small Bodies Node of the NASA Planetary Data System](#). The MPC collects, processes, and distributes all positional measurements, orbits, and discovery information for all minor planets and comets (and some natural satellites too). The MPC also alerts the [NASA Planetary Defense Coordination](#)



MPC Database Tables Schema

The MPC makes its PostgreSQL database of observations and orbits available for replication via the SBN. Additional information on the replicated tables, including examples and status reports, can be found here ([add link to the MPC Database User Guide](#)).

The table below shows the **name** and **description** for all the tables that are currently replicated to the SBN.

By clicking on the name of each table, you will get to the page of the schema of the specific table, including the column names, types, and descriptions.

Please click on the header to change the columns order.

Table name	Description
current_identifications	Table containing all the primary designations (minor planets, comets and natural satellites) and their secondary designations, when available.
mpc_orbits	Table containing orbits and related information for any minor planet that has been designated and for which it is possible to fit an orbit with the available observations.
neocp_obs	Table containing the nominal orbital element for each tracklet that is currently on the NEOCP
neocp_events	Table containing NEOCP-related processing events
neocp_obs	Table containing observations for objects currently on the NEOCP
neocp_obs_archive	Table containing archived NEOCP observations
neocp_obs_del	Table containing objects that were previously listed on the NEOCP; their designation if designated and the reasons for their removal.
neocp_var	Table containing variant orbits for every object on the NEOCP
numbered_identifications	Table containing the number and primary provisional designation for any object that have been numbered.
obs_corrections_corrections	Table used to record the corrections made to the observations that have been published.
obs_corrections_deletions	Table used to record the observations that have been published by the MPC (in an MPEC, DDU or monthly circular) and that have been also deleted
obs_corrections_redesignations	Table used to record the observations that have been redesignated
obs_corrections_unassociated	Table used to record the observations that were unassociated from their original designation and relocated to the Isolated Tracklet File (ITF)
obs_itf	Table used to record all the observations published by the MPC. Contains observations associated with designated objects and observations associated with the Isolated Tracklet File (ITF).
primary_objects	Table used to keep a record of all the primary designations for minor planets, comets and natural satellites that have been designated by the MPC.

Multiple postgres database tables are now available for replication via the SBN

Available Now

- Designations and Identifications
- Observations
- NEOCP
- Orbits

SBN

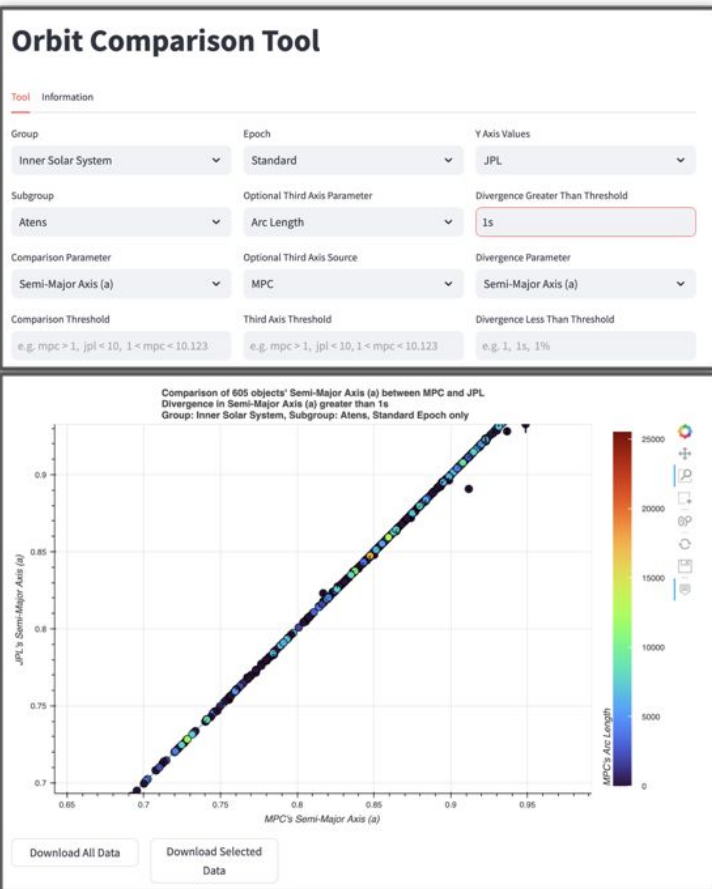
- MPCDB now distributed via AWS
 - Increased redundancy

URL & QR-Code

- <https://sbnmpc.astro.umd.edu/>
- <https://data.minorplanetcenter.net/mpcops/documentation/replicated-tables-schema/>



Orbit Comparison Tool



Compare the MPC's orbit for an object with that calculated by another center.

- Identify discrepancies

Available Now

- JPL/CNEOS orbits

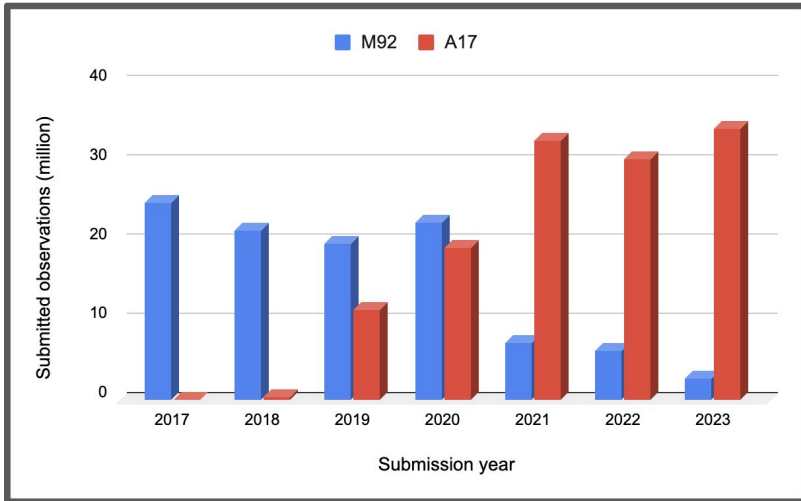
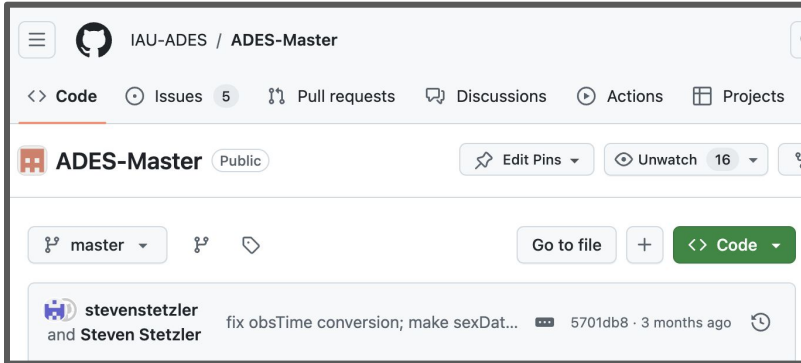
Coming Soon

- NEOfixer orbits

URL & QR-Code

- <https://data.minorplanetcenter.net/comparison/index.html>





Preferred submission format

Preferred format for internal MPC processing

The GitHub repository containing the ADES code is continuously updated if fixes or improvement are needed:

- Co-maintained by JPL & MPC
- Available for public download
- Available for public *discussion* of issues and improvements



[URL & QR-Code](https://github.com/IAU-ADES/ADES-Master)

<https://github.com/IAU-ADES/ADES-Master>

ADES-Master / new_tests / input / K20Q04A_test.obs

federicaspotto Files renamed to .py, tests added 307ac33 · last year History

Code Blame 12 lines (12 loc) · 972 Bytes Raw

```

1 K20004A* C2020 08 18.33489021 33 58.060+12 13 25.77 22.58WU~44BVF51
2 K20004A C2020 08 18.34598621 33 57.382+12 13 14.45 22.24WU~44BVF51
3 22.58WU~44BVF51
4 -fjgit_repos/ADESResiduals/ADES-Master/new_tests 22.29WU~44BVF51
5 <?xml version='1.0' encoding='UTF-8'?> 22.2 Vu~44BVH21
6 <ades version="2022"> 22.2 Vu~44BVH21
7 <optical>
8 <provID>2020 QA4</provID>
9 <mode>CCD</mode>
10 <stn>F51</stn>
11 <obsTime>2020-08-18T08:02:14.50Z
12 <ra>323.491917</ra>
    <dec>12.223825</dec>
    <astCat>Gaia1</astCat>
    <mag>22.58</mag>
    <band>w</band>
    <ref>MPS 1229401</ref>
    <disc>*</disc>
    <subFmt>M92</subFmt>
    <precTime>1</precTime>
    <precRA>0.001</precRA>
    <precDec>0.01</precDec>
  </optical>
  <optical>
    <provID>2020 QA4</provID>
    <mode>CCD</mode>
    <stn>F51</stn>
    <obsTime>2020-08-18T08:18:13.19Z
    <ra>323.489092</ra>
    <dec>12.220681</dec>
    <astCat>Gaia1</astCat>
    <mag>22.24</mag>
    <band>w</band>
    <ref>MPS 1229401</ref>
    <subFmt>M92</subFmt>
    <precTime>1</precTime>
    <precRA>0.001</precRA>
    <precDec>0.01</precDec>
  </optical>

```

ADES-Master / new_tests / input / obs.xml

Code Blame 132 lines (132 loc) · 4.09 KB

```

40 <obsData>
41 <optical>
42 <provID>2022 KW</provID>
43 <mode>CCD</mode>
44 <stn>T12</stn>
45 <obsTime>2023-06-15T13:44:30.18Z</obsTime>
46 <ra>325.589699</ra>
47 <dec>+0.560433</dec>
48 <rmsRA>0.033</rmsRA>
49 <rmsDec>0.033</rmsDec>
50 <astCat>Gaia2</astCat>
51 <mag>22.458</mag>
52 <rmsMag>0.069</rmsMag>
53 <band>G</band>
54 <photCat>Gaia2</photCat>
55 <photAp>1.2</photAp>
56 <logSNR>1.20</logSNR>
57 <seeing>1.3</seeing>
58 <exp>420.0</exp>
59 <rmsFit>0.049</rmsFit>
60 <nStars>395</nStars>
61 <remarks>S: 0.0018 0.0031 0: 0.0328 0.
62 </optical>

```

Switching to ADES

If you are still using the 80-character format, some help with switching can be found in the ADES repo.

There is code that converts 80-char to ADES format:

- <https://github.com/IAU-ADES/ADES-Master/blob/master/Python/bin/mpc80coltoxml.py>

The above will just help get you underway ...

- You probably want to add uncertainties ...

There are examples of data that include uncertainties

- https://github.com/IAU-ADES/ADES-Master/blob/master/new_tests/input/obs.xml



MPC Documentation

Frequently Asked Questions (FAQ)

- [List of FAQs](#)

MPC APIs

- Where Are My Observations (WAMO)
[WAMO API](#) documentation.
- Designation Identifier
[Designation Identifier API](#) documentation.
- Observations
[Observations API](#) documentation.

MPC's replicated postgresSQL tables

- [Introduction and examples](#)
- [Schema](#)

Improvements to website documentation.

- [April 2024 Newsletter](#)

Documentation Page

- <https://minorplanetcenter.net/mpcops/documentation/>
- API related documentation
- PostgreSQL replicated table documentation

MPC Documentation

Frequently Asked Questions (FAQ)

- [List of FAQs](#)

MPC Guide to minor planet astrometry

- [How do I begin?](#)
- [How do I report observations to the Minor Planet Center?](#)
- [How do I get an observatory code?](#)
- [How do I submit my astrometry to the MPC using Tycho Tracker?](#)

MPC APIs

- [Where Are My Observations \(WAMO\)](#)
[WAMO API documentation.](#)
- [Designation Identifier](#)
[Designation Identifier API documentation.](#)
- [Observations](#)
[Observations API documentation.](#)
- [NEOCP Observations](#)
[NEOCP Observations API documentation.](#)

MPC's replicated PostgreSQL tables

- [Introduction and examples](#)
- [Schema](#)

ADES related documentation

- [Introduction](#)
- [Valid ADES values](#)
- [GitHub repository](#)
- [Official format description](#)

Improvements to website documentation.

- [April 2024 Newsletter](#)

Ongoing improvements

- Reorganized & Updated Guide to Astrometry
- Reorganized & Updated Guide to the ADES format

Our goal is to keep improving this documentation section

- Reorganizing & Updating material from across the website.

MPC Explorer

Designation NEOCP **Documentation** Known Issues

Introduction

MPC Explorer is a user-friendly web application that allows you to search for an object, resolve its identity, and retrieve information on its designation, observations (and orbits, in the future).

The application is designed to replace the [db_search](#) functionality, and to provide a simple interface to the Minor Planet Center's APIs. MPC Explorer is able to resolve both designations for designated objects and trksubs for objects on the NEOCP.

Search terms include the object's name (e.g. Ceres, bennu), the object's packed or unpacked number (e.g. 101955, 00001, ~0000, 401P, Jupiter IX, J0095), or the object's [packed or unpacked provisional designation](#), with or without spaces (e.g. K23A00B, 2024AA, 2019 JD4, C/2019 Y4, CK18Y010, S/2020 S1, SK03J020, S/2003 X2). Search can also be done using either the primary or one of the secondary designations. The designation identifier will resolve the ID for you. Natural satellites are also supported: the search can be done using the packed or unpacked permanent or provisional designation.

Search can also be done using the trksub (see the NEOCP tab). The NEOCP tab is only to be used for objects that are currently on the NEOCP.

Designated objects

Designation

The Designation tab displays the resolved designation of the object. This includes:

- *Name*: The name of the object, if available.
- *Permanent ID*: The permanent ID of the object (unpacked number), if available.

Improvements to website documentation.

- [April 2024 Newsletter](#)

Ongoing improvements

- Reorganized & Updated Guide to Astrometry
- Reorganized & Updated Guide to the ADES format

Our goal is to keep improving this documentation section

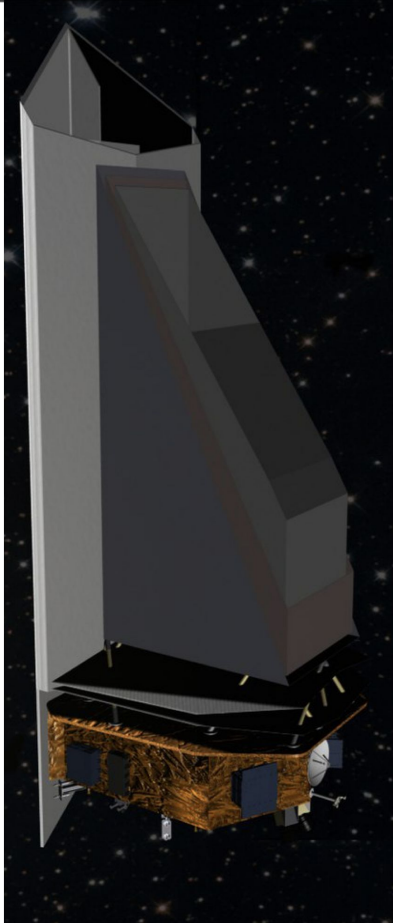
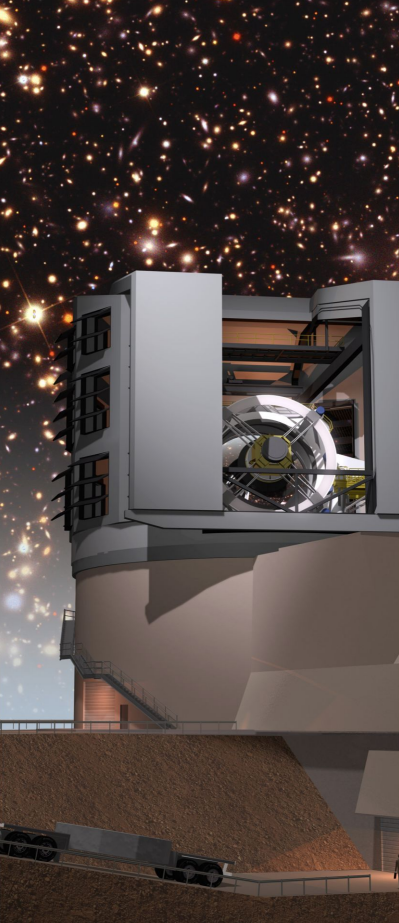
- Reorganizing & Updating material from across the website.
- Cross-linking to updated documentation

Infrastructure Updates



Preparing for the Future

The MPC's infrastructure updates are centered around preparing for the Vera Rubin/LSST and the NEO Surveyor mission.



MPC Staff are using modern software practices

Entire team is comfortable with Jira



Jira Software

Branching training turning into adoption



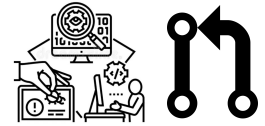
Adopting latest Python packaging standards



More unit tests running in the cloud every commit

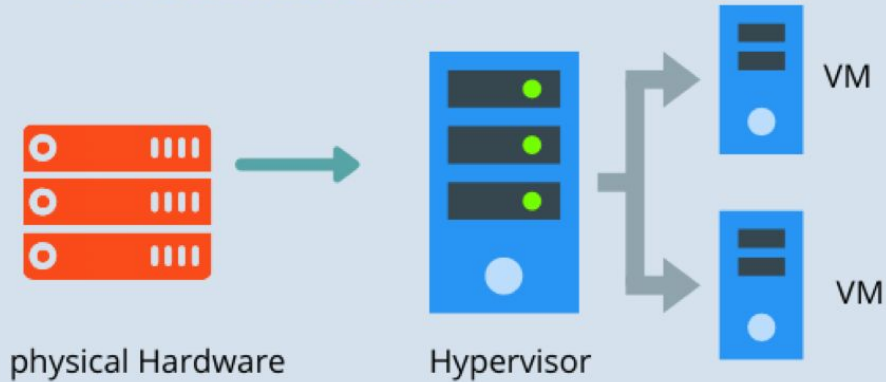


More Code Reviews and Human Testing



- Three full-time software engineers
- Recently advertised additional positions for database & software staff

Virtualization



- Created our own internal cloud system
 - Multiple servers
 - Large, modern storage
 - Cluster: Software hypervisor
 - Deploy multiple VMs and containers to the cluster
- Efficient resource use
- Faster processing times
- Simple backup and upgrade paths
- Faster disaster recovery

Orbit Fitting Containers

Orbit-Fitting

- Group of containers orchestrated via *Docker Swarm*.
- Deployed onto virtualized cluster
- Multiple workers per container
- Each worker is running orbit fitting jobs using the MPC's `pyorbfit` wrapper around the `orbfit` fortran binary.

mpc-software / mpc-pyorbfit /

README.md

PyOrbfit

This project provides...
with additional evaluation...
orbfit wrapper must...

There are additional...
[Utilities](#)

Structure

The project can be...

Orbfit.prepa...

Orbfit Prepar...

Orbfit.prepara...
database and crea...

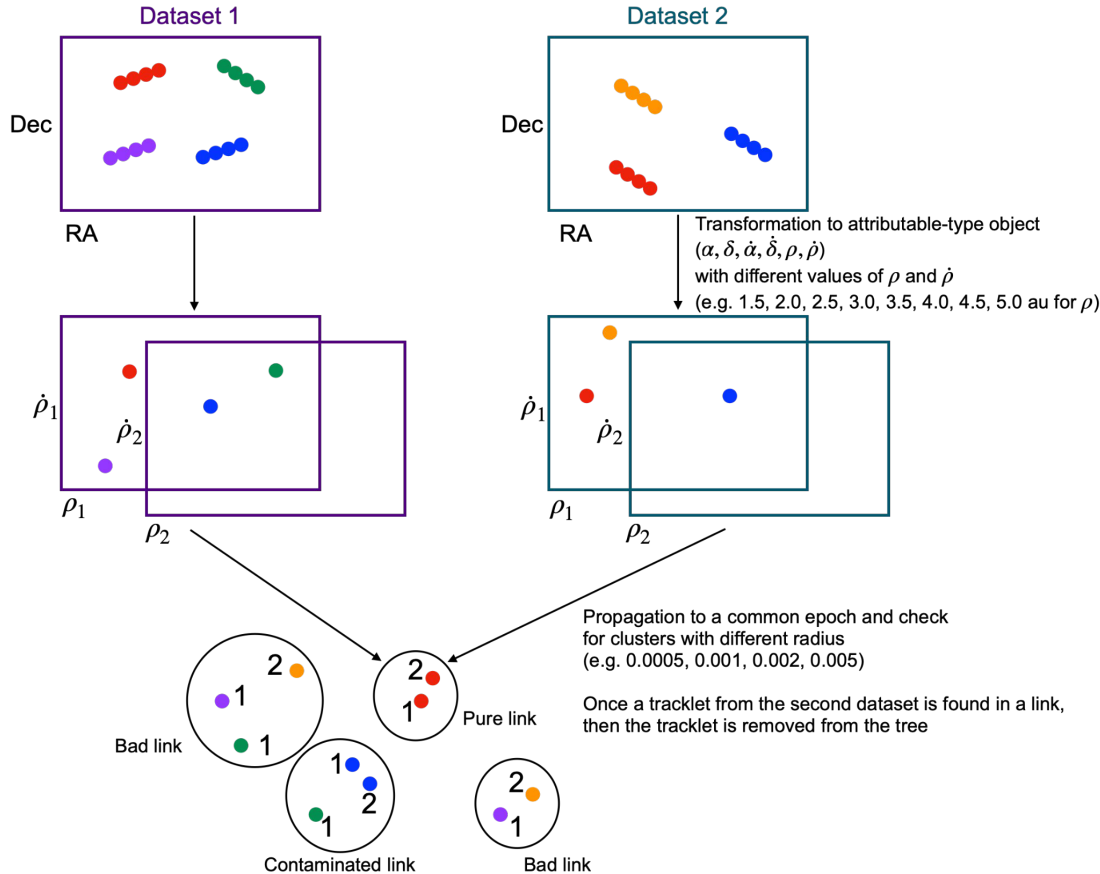
Orbit Fitting

Orbfit.fit() i...
the OrbfitResu...

Orbfit Evalua...

The screenshot shows the Xen Orchestra web interface. A dark blue sidebar on the left contains a navigation menu with items: Home, Dashboard, Self service, Backup, XOA, Settings, Jobs, Hub, Proxies, About, Tasks, XOSTOR, Import, and New. The main content area is titled 'VM' and shows a list of 15 containers. The first container is selected, indicated by a blue bar. The list of containers includes: Portainer, XOA, db1, db2, freeipa, heliolinc, monitor, nfs, public, rabbitmq, swarm-manager1, swarm-worker1, and swarm-worker2. Each container has a green status indicator and a checkbox.

Heliocentric Linking



HelioLinc Algorithm

- *Guess/assert a distance (and radial velocity)*
- *Transform tracklets to state-vectors*
- *Propagate*

Look for “Clusters”

- *If the assertion is true, tracklets from the same object will “cluster” at a common location after propagation.*
- *If you see clusters, you have found an object with those (approximate) properties*

Heliocentric Linking

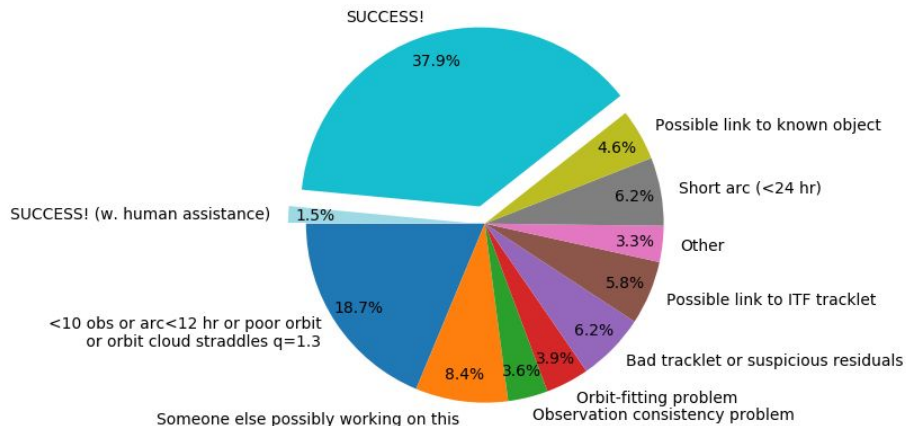
The screenshot shows a GitHub repository for 'mpc-heliolinc' with a file explorer on the left and a commit page for 'mpc-heliolinc'. A red arrow points from the 'heliolinc' entry in a Xen Orchestra VM list to the text in the adjacent box.

VM	Filters
<input type="checkbox"/> 15x (of 15)	
<input type="checkbox"/> Portainer	
<input type="checkbox"/> XOA	
<input type="checkbox"/> db1	
<input type="checkbox"/> db2	
<input type="checkbox"/> freeipa	
<input type="checkbox"/> heliolinc	
<input type="checkbox"/> monitor	
<input type="checkbox"/> nfs	
<input type="checkbox"/> public	
<input type="checkbox"/> rabbitmq	
<input type="checkbox"/> swarm-manager1	
<input type="checkbox"/> swarm-worker1	
<input type="checkbox"/> swarm-worker2	

Linking Development

- WIP to migrate the code to database-centered data format;
 - **Radiy Matveev**
- To be deployed to virtual machine
- Integrate into the RabbitMQ-based queuing system ...

NEOCP Automated Processing last message
for 2548 objects from 2024-01-01 to 2024-09-16



NAP:

- An automated script process and designate objects on the NEOCP
- Regularly develop and improve: increase level of automation

Checks:

- Objects are thoroughly vetted prior to publication: a Huge number of properties are checked
- Recently added / improved checks include:
 - Orbit uncertainties
 - Differences in magnitude between the object and the possible ITF matches
 - Geocentric score
 - Singletons

WIP:

- Increase Automation

Old (1): NEOCP Follow-up reports

2024-02-20 12:59:16 UTC

I52 — Steward Observatory, Mt. Lemmon Station
K24D00Z
targeting - I52

691 — Steward Observatory, Kitt Peak-Spacewatch
Attempting recovery of K24C08N
Started recovery attempt for K24C08N on 2024 Feb 20 at
approximately 1228 UT

2024-02-20 13:12:18 UTC

I52 — Steward Observatory, Mt. Lemmon Station
CA9CDD2
reported - R. A. Kowalski

https://www.minorplanetcenter.net/neocp_followup_reports/

Negative Observations

- Allow users to report objects that could *not* be recovered.
- *Partial* evidence against an orbit / variant-orbits
- Difficult topic: many caveats around depth, completeness, etc.
- But we want to start collecting information: hopefully something is better than nothing.

Old (2): Pointings

id	1
surveyexpname	
mode	survey
mpccode	691
time	2008-01-01 00:00:00
astrometric	f
date_only	t
duration	0
jdmid	2454466.5
ra	71.871
dec	29.342
ra_sw	70.813
dec_sw	28.477
ra_se	72.929
dec_se	28.477
ra_ne	72.947
dec_ne	30.207
ra_nw	70.795
dec_nw	30.207
width_ra	1.86
width_dec	1.73
rot_angle	0
fielddiam	1.73
circular	f
healf	294760974
healc	1124
desig	
maglimit	21.7
nonSidereal	f
filter	
ignore	0
rawjson	
created_at	2018-10-24 20:14:04.515747
updated_at	2018-10-24 20:14:04.515747

<https://minorplanetcenter.net/pointings>

Negative Observations

- Allow users to report objects that could *not* be recovered.
- Partial evidence against an orbit / variant-orbits
- Difficult topic: many caveats around depth, completeness, etc.
- But we want to start collecting information: hopefully something is better than nothing.

New: Updated Pointings API → Negative Observations

You can specify a **negative observation** of an object when you searched for a given object but could not find it in a field. This information is specifically desired for NEOCP objects. The following keywords are MANDATORY in case of a negative observation:

- **found** - boolean, true or false, (was the object found?)
- **desig** - object designation in a packed format (known object - 5,7,8 characters, string) or a trksub for NEOCP
- **submitter** - name of the submitter who reported the negative observation (string, e.g. 'A. Tomatic')

OPTIONAL fields that can be provided with the negative observation:

- **limiting_mag_method** - integer: allowed values 1, 2, 3, 4 (explained below).
- **notes** - string, up to 255 characters.
- **number_of_stars_fov** - number of stars in the field (>0, integer), helpful information when the field is crowder or not crowded.
- **pixel_scale** - float, number > 0, in arc seconds.
- **seeing** - float, number > 0, in arc seconds.
- **software** - string, software used for image processing and reduction.
- **stacked** - boolean (true/false)
- **fill_factor** - fill factor, a number > 0 and <=1 (1 means entire field is visible).

Limiting magnitude methods:

- 1 - On star stack, measure faint objects at the limit, and scale their magnitude to 5-sigma.
- 2 - On stack, measure sky noise. Scale for area of a point-source. Scale for 5-sigma.
- 3 - Insert artificial objects in individual frames, find them in stacks and sub-stacks (limiting magnitude where detection efficiency is equal to 50%).
- 4 - Manual/custom method.

New: Updated Pointings API → Negative Observations

Minimal Example

```
{
  "action": "exposed",
  "surveyExpName": "20180101-EX0132",
  "mode": "target",
  "mpcCode": "I52",
  "time": "2024-03-03T12:20:33.46",
  "duration": 45,
  "center": [255.167, -29.008],
  "widths": [0.82, 0.64],
  "desig": "P11Uypl",
  "limit": 22.7,
  "nonsidereal": true,
  "filter": "V",
  "found": false,
  "submitter": "A. Tomatic",
  "fill_factor": 0.98
}
```

More Verbose Example

```
{
  "action": "exposed",
  "surveyExpName": "20180101-EX0132",
  "mode": "target",
  "mpcCode": "I52",
  "time": "2024-03-03T12:20:33.46",
  "duration": 45,
  "center": [255.167, -29.008],
  "widths": [0.82, 0.64],
  "desig": "P11Uypl",
  "limit": 22.7,
  "nonsidereal": true,
  "filter": "V",
  "found": false,
  "submitter": "A. Tomatic",
  "fill_factor": 0.98,
  "limiting_mag_method": 4,
  "notes": "I searched a lot, not found, large chip gap in FOV",
  "number_of_stars_fov": 1000,
  "pixel_scale": 0.4,
  "seeing": 1.2,
  "software": "Tycho tracker",
  "stacked": true
}
```

Survey Preparations

- LSST
 - Main survey starts next summer
 - Com-Cam data expected October 2024
- Infrastructure developments
 - Many pipeline upgrades
 - Deploying “Sandbox Pipelines” in collaboration with LSST
- NEO Surveyor
 - MOUs & ICDs Signed
 - Ongoing testing schedule

Community Wide Improvements

- New Services and Data Products
 - Database-Centric Data & Services
- Improving Communication and Documentation
 - Newsletters
 - Helpdesk
 - Talks/Conferences/Workshops
- Let us know how we can help!
 - Jira Helpdesk
 - Open to suggestions!